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CLAIMS

1. A method for determining a position of an acoustic receiver, comprising:
determining a plurality of acoustic ranges from at least a first signal source position and a second signal source position, respectively, to the acoustic receiver;
ascertaining a non-acoustic constraint on the acoustic receiver's position; and
determining the acoustic receiver's position from the first and second acoustic ranges and the non-acoustic constraint.

2. The method of claim 1, wherein ascertaining the non-acoustic constraint includes one of sensing an angular orientation of the acoustic receiver, sensing a heading of the acoustic receiver, sensing a water depth of the acoustic receiver's position, retrieving an archived water depth measurement for the acoustic receiver's position, and retrieving a stored distance from a known second position to the acoustic receiver's position.

3. The method of any preceding claim 1 to claim 2, wherein determining the acoustic receiver's position from the acoustic ranges and the non-acoustic constraint includes:
determining an intersection of a first sphere defined by the first signal source position, a second sphere defined by the second signal source position, and a plane defined by the non-acoustic constraint; and
selecting one point of the intersection.

4. The method of claim 3, wherein selecting the one point of the intersection includes one of determining the intersection of a third sphere defined by a third signal source position, determining a water depth at the acoustic receiver's position, and eliminating a second point of intersection as physically improbable.

5. The method of any preceding claim 1 to claim 2, wherein determining the position from the acoustic ranges and the non-acoustic constraint includes:
modeling the acoustic receiver's position from historical positions associated with the acoustic receiver's position; and
applying an inversion algorithm to constrain the modeled position with the non-acoustic constraint.

6. The method of claim 5, wherein applying the inversion algorithm includes applying a linear regression or a least squares fit.

7. The method of claim 5, wherein the acoustic receiver's position is determined dynamically as the position changes over time through the historical positions.

8. The method of any preceding claim 1 to 6, wherein the acoustic receiver's position is determined dynamically as the position changes over time.

9. The method of any preceding claim 1 to 8, further comprising performing the method for a plurality of points.

10. The method of claim 9, wherein the points are constrained to points on a cable.

11. The method of claim 10, further comprising determining the shape of the cable from the determined positions.

12. The method of claim 1, further comprising determining an acoustic range from a third signal source position.

13. An apparatus, comprising:

at least one acoustic source;

an acoustic receiver capable of receiving a plurality of acoustic signals transmitted by the at least one acoustic source from at least two signal source positions; and

a computing system programmed to determine a position of the acoustic receiver from the acoustic ranges between the at least two signal source positions and the acoustic receiver and a non-acoustic constraint.

14. The apparatus of claim 13, wherein the at least one acoustic source comprises an airgun.

15. The apparatus of claim 13, further comprising a sensor located at the position of the acoustic receiver to sense the non-acoustic constraint.

16. The apparatus of claim 15, wherein the sensor is one of an angular orientation sensing device, a heading sensor, and a water depth sensor.

17. The apparatus of claim 15, wherein the sensor comprises one of means for sensing an angular orientation of the position, means for sensing a heading for the position, and means for sensing a water depth.

18. The apparatus of claim 13, wherein the computing system is further programmed to analytically determine the position.

19. The apparatus of claim 18, wherein the computing system is further programmed to, for the acoustic receiver's position:

determine the intersection of a first sphere, a second sphere, and a plane, the first sphere and the second sphere being defined by the acoustic ranges and the plane being defined by the non-acoustic constraint; and

select one point of the intersection.

20. The apparatus of claim 19, wherein the computing system is further programmed to impose the non-acoustic constraint in selecting the one point of the intersection.

21. The apparatus of claim 20, wherein the non-acoustic constraint is one of an angular orientation of the acoustic receiver, a third acoustic range from a third signal source to the acoustic receiver, a water depth measurement for the acoustic receiver's position, and a heading for the acoustic receiver.

22. The apparatus of claim 18, wherein the computing system is further programmed to analytically determine the acoustic receiver's position dynamically as the position changes over time.

23. The apparatus of claim 13, wherein the computing system is further programmed to, for the acoustic receiver's position:

model the acoustic receiver's position from historical positions associated with the position; and

apply an inversion algorithm to constrain the modeled position with the non-acoustic constraint.

24. The apparatus of claim 23, wherein the computing system is further programmed to apply at least one of a linear regression and a least squares fit in applying the inversion algorithm.

25. The apparatus of claim 23, wherein the acoustic receiver's position is determined as the position changes over time through the historical positions.

26. The apparatus of claim 13, wherein the non-acoustic constraint is one of a third acoustic range from a third signal source position to the acoustic receiver, a water depth measurement for the acoustic receiver's position, an angular orientation of the acoustic receiver, and a heading for the acoustic receiver.

27. The apparatus of claim 13, further comprising a cable on which the acoustic receiver is deployed.